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Specification and Drawing, as originally filed, with Application for Patent Serial No:
2,366,470, on December 28, 2001, by **DIVERSIFIED INDUSTRIES LTD.**, assignee of
Stephen Lee Davis and William Dale Storey, for "Solution and Method for Scavenging
Hydrogen Sulphide"

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Patent Application

SOLUTION AND METHOD FOR SCAVENGING HYDROGEN SULPHIDE

FIELD OF THE INVENTION

This invention relates to solutions that can be used in removing hydrogen sulphide from gases and liquids.

BACKGROUND OF THE INVENTION

Hydrogen sulphide is a colorless gas, with an odor of rotten eggs. It is produced by bacterial action during the decay of both plant and animal protein and can be formed wherever elemental sulphur or certain sulphur-containing compounds come into contact with organic materials at high temperatures. In industry, it is usually an unintended byproduct, for example from the production of coke from sulphur-containing coal, from the refining of sulphur-containing crude oils, the production of disulphide, the manufacture of vicos rayon, and in the Kraft process for wood pulp.

Natural gases with high concentrations of hydrogen sulphide are known as "sour gases".

Hydrogen sulphide in sour gas and crude oil streams is separated during the "sweetening" process. The most widely used sweetening processes in the industry are the amine processes, which use a solution of water and a chemical amine to remove carbon dioxide and several sulphur compounds.

Hydrogen sulphide is also a byproduct of wastewater from treatment plants or water from agricultural practices. Additionally, hydrogen sulphide can be responsible for the unpleasant odor from liquids used in janitorial processes, RV holding tanks, portable toilets and the like. If the emission of hydrogen sulphide from these liquids can be controlled, then the unpleasant odors may be eliminated.

Hydrogen sulphide is toxic to humans and other animals, and represents a significant threat to public safety and health. It can cause serious health risks, most notably in the oil and gas, livestock, waste management and janitorial industries. At 200 parts per million, humans can no

longer smell the gas, and therefore can no longer detect it by smell. Higher concentrations than this can cause nausea and headaches. At 500 to 1,000 parts per million, it causes unconsciousness, with death following in two to twenty minutes unless the victim is removed from the area of exposure immediately.

- 5 There is a need for a simple, economical and effective means of capturing hydrogen sulphide gas that is present in other gases, or in liquids.

SUMMARY OF THE INVENTION

This invention provides a solution that can be used to capture hydrogen sulphide, and methods for its use. In one embodiment, this invention is a solution for removing hydrogen sulphide from
10 gases, said solution comprising sulphuric acid, a metal, an amine and water. In another embodiment, the invention is a solution for removing hydrogen sulphide from gases, said solution comprising sulphuric acid, a metal, mixed amines and water. In another embodiment the solution comprises sulphuric acid in the form of a chelate, a metal, amines and water. In
15 another embodiment, the solution comprises sulphuric acid in the form of a chelate, a metal, mixed amines and water.

In another embodiment the invention is a solution for removing hydrogen sulphide from gases, comprising:

- (a) sulphuric acid, at between about 0.1 to 2 percent by volume of the solution;
- (b) a metal, at between about 0.05 to 10 percent by weight of the solution;
- 20 (c) an amine or a mixed amine at between about 10 to 85 percent by volume of the solution; and
- (d) water, at between about 20 to 80 percent by volume of the solution.

In one embodiment, the metal is copper, in another embodiment the metal is zinc and in yet another embodiment the metal is a mixture of copper and zinc. In another embodiment the metal
25 is iron.

In one embodiment the amine is monoethanolamine, in another embodiment it is mixture of amines.

In another embodiment, the solution comprises additionally an antifreeze agent, which may be methanol, or a glycol such as ethylene glycol, or a mixture of methanol and a glycol.

- 5 In yet another aspect, this invention is a solution comprising an amine and sulphuric acid, or an amine, sulphuric acid and a metal, which solution has a freezing point that is less than 0°C and can therefore be used in colder environments without the addition of an antifreeze agent.

10 In yet another aspect, this invention is a method for using the above solution, which method comprises contacting the gas from which the hydrogen sulphide is to be removed, with the solution.

- 15 In one embodiment, the method comprises introducing the solution into a container that has an entrance opening to allow the gas into the container and an exit opening to allow the gas to exit the container. The entrance and exit openings are positioned such that, in order to exit the container through the exit opening after being introduced into the container through the entrance opening, the gas must pass through the solution. In this method, the gas is introduced into the container through the entrance opening, and it exits through the exit opening after passing through the solution.

- 20 In another embodiment of this method the solution is introduced into a container that has an entrance opening to allow the gas into the container and an exit opening to allow the gas to exit the container, a plurality of tortuous paths, and a means of introducing the solution to the container such that it will flow along the tortuous paths and be collected thereafter. The entrance and exit openings are positioned such that in order to exit the container through the exit opening after being introduced into the container through the entrance opening, the gas must pass along the tortuous paths. In this embodiment of the method, the solution is first introduced into the container, and while it is flowing along the tortuous path, the gas is introduced into the container through the entrance opening, whereafter it flows along the tortuous path and exit the container through the exit opening. The solution is collected after flowing through the tortuous path.
- 25

In one embodiment placing a plurality of inert objects with rounded edges into the container creates the tortuous path.

In another embodiment of this method, the gas is collected upon exit from the exit opening.

In yet another embodiment, the gas is air.

- 5 In yet another aspect, this invention is a method for using the above solution, which method comprises mixing the solution with another liquid that contains hydrogen sulphide.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

- 10 The solution of this invention is made by mixing together an acid, a metal, an amine or mixed amines, and water. The solution can be used to remove hydrogen sulphide from gases and liquids, or in any situation where hydrogen sulphide gas is generated. Particularly, it may be used to remove hydrogen sulphide from natural gas collected from gas wells.

The solution of this invention is a mixture of an acid, a metal, an amine and water. In another embodiment, the solution of this invention is a mixture of an acid, a metal, mixed amines and water.

- 15 In one embodiment the acid component of the solution of this invention is sulphuric acid. Various embodiments of the solution of this invention include sulphuric acid at about 0.5, 0.6 or one percent by volume of the final volume of the solution. In another embodiment, the range of sulphuric acid is between about 0.1 to 2 percent by volume of the final volume of the solution.

- 20 In another embodiment, the sulphuric acid is in the form of a chelate, which is a derivative of a sulphur based acidic compound. This derivative is formed by use of a proprietary process applied to sulphuric acid, and has the added benefit of having a very low level of corrosiveness to human or animal tissue, while still being a strong acid. Chelate, as used herein means the process that traps and binds certain metal ions to hold them in suspension in liquids. Metal ions that are suspended in liquid will not dissolve as quickly and will bind with bacteria or other
- 25 metal ions. The feature of chelation is important because it improves odour control, increases the effectiveness and performance of products such as herbicides and pesticides and permits precious metal extraction without the need for caustic chemicals.

One source of sulphuric acid in the form of a chelate is Stabitol™, which is available from Cheltec, Inc. in a solution that comprises the equivalent of about 19.9 percent sulphuric acid. Various embodiments of the solution of this invention include sulphuric acid that is in the form of a chelate at about 0.5, 0.6 or one percent by volume of the final volume of the solution. In
5 another embodiment the range of sulphuric acid in the form of a chelate is between about 0.1 to 2 percent by volume of the final volume of the solution.

In one embodiment the metal component of this solution is copper. In one embodiment, the amount of copper in the solution of this invention is between about 1 to 99 percent by volume of an about 5 percent by weight solution of copper. Particular embodiments of the solution of this
10 invention include copper, in the form of an about 5 percent by weight solution of copper, at about 25, 30 or 50 percent by volume of the solution. The copper may be derived from mixing solid copper sulphate pentahydrate with water or another liquid. Solid copper sulphate pentahydrate useable in the methods of this invention may be obtained from HCl Canada Inc., in the form of a solid that is 25.2 percent copper.

15 In another embodiment the metal component of the solution is zinc. In one embodiment the amount of zinc in the solution of this invention is between about 1 to 99 percent by volume of an about 9 percent by weight solution of zinc. In another embodiment zinc, in the form of an about 9 percent by weight solution of zinc, comprises about 30 percent by volume of the solution. The zinc in the solution may be derived from mixing solid zinc sulphate monohydrate with water or
20 another liquid. Solid zinc sulphate monohydrate useable in the methods of this invention may be obtained from Tetra Micronutrients, in the form of a solid that is 35.5 to 38 percent zinc.

Alternatively, the solution of this invention may be selected from the group of iron, manganese or magnesium. The iron in the solution may be derived from mixing solid iron sulphate with water or another liquid. The inventors are able to chelate all of these metals.

25 The amine component of the solution is added as a substantially pure liquid of the amine, or solution of mixed amines. Amines are a colourless, viscous, flammable liquid with a fishy, ammonia-like odor, and they are miscible in water, acetone and methanol. One embodiment of the solution comprises amines in the range of between about 10 to 85 percent by volume of the solution. In one embodiment the amine is monoethanolamine, otherwise known as

ethanolamine. Various embodiments of the solution of this invention include monoethanolamine at about 16, 25, 30 or 50 percent by volume of the final volume of the solution.

The inventors have shown that if the amine component of the solution comprises about 2 percent by volume of the final volume of the solution, the solution is stable, meaning that the metal component remains in solution. However, the solution does not work as well as when the amine component is present at a higher percentage. If the amine component of the solution comprises between about 2 and 10 percent by volume of the final volume of the solution, the inventors have shown that solution becomes unstable, in that the metal component will precipitate out of solution.

10 The inventors have used monoethanolamine, but other embodiments of the solution may contain other amines, or a mixture amines.

The last component of the solution of this invention is water, which is used to bring the volume of the solution to its desired final volume. One embodiment comprises water at a final volume percentage of between about 20 to 80 percent of the final volume of the solution. Other
15 embodiments comprise water at about 27, 40, or 45 percent by volume of the final volume of the solution.

The inventors have shown that various embodiments of the solutions of this invention do not freeze at even as low as -51°C, and can thusly be used to remove hydrogen sulphide in very cold environments. The results of these tests are described more fully in the Examples contained
20 herein. This significant depression of the freezing point was a completely unexpected result. The solution may optionally contain an antifreeze agent. The antifreeze agent may be present by up to about 75 percent by volume of the solution. The antifreeze agent can be methanol, or a glycol such as ethylene glycol, or a mixture of ethylene glycol and methanol.

Having thus disclosed the various components of the solution, an example of how the solution is prepared will now be disclosed. This invention is not intended to be limited by the order or
25 method in which the components are mixed together.

The inventors firstly mix the metal and acid together. One method of preparing this metal/acid mixture is to mix 45 gallons of water with 5 gallons of sulphuric acid that is in the form of a

chelate, for example, Stabitol™ obtained from Cheltec. Two 50 pound bags of the solid copper sulphate pentahydrate obtained from HCI Canada Inc., in the form of a solid that is 25.2 percent copper, may then added with mixing. This metal/acid solution will therefore comprise about 5 percent by weight copper and about 1.99 percent by volume, of sulphuric acid in the form of a chelate. Alternatively, if zinc is the metal component of the solution, solid zinc sulphate monohydrate obtained from Tetra Micronutrients, in the form of a solid that is 35.5 to 38 percent zinc, is added with mixing, to a final concentration of about 9 percent zinc by weight.

The metal/acid/water mixture is then added to any additional water that will comprise the solution. Alternatively, any additional water required may be added to the amine component. The metal/acid mixture is slowly added to the amine component, with mixing to prevent precipitation of the metal. When the metal is zinc, mixing must be particularly vigorous, as zinc will otherwise precipitate out of the solution. The inventors have noticed that the temperature of the solution, upon mixing of the metal/acid mixture with the amine will rise, in some instances up to 120°F, indicating that some type of chemical reaction has occurred. The solution is then allowed to cool before use in the methods of this invention. It should be noted that, if the amine component is present about 10 percent by volume of the final volume of the solution, or less, the temperature change to 120°F does not occur.

If an antifreeze agent is to be used it may be added at any stage and to any component, as it does not appear to have any affect on the mixing procedure.

One embodiment of the solution comprises about 30 percent by volume of the 5 percent copper:1.99 percent acid mixture disclosed above; about 16 percent by volume monoethanolamine; about 40 percent by volume ethylene glycol, and about an additional 13.5 percent by volume water.

In another embodiment, the solution comprises about 30 percent by volume of the 5 percent copper:1.99 percent acid mixture disclosed above; about 30 percent by volume monoethanolamine, and about 40 percent by volume methanol.

In another embodiment, the solution comprises about 30 percent by volume of the 9 percent zinc:1.99 percent acid mixture disclosed above; about 30 percent by volume monoethanolamine, and about 40 percent by volume ethylene glycol.

5 In another embodiment the solution comprises about 50 percent by volume of the 5 percent copper:1.99 percent acid mixture disclosed above and about 50 percent by volume monoethanolamine.

10 In another embodiment the solution comprises about 25 percent by volume of the 5 percent copper:1.99 percent acid mixture disclosed above; about 16.7 percent by volume monoethanolamine, about 41.6 percent by volume ethylene glycol and about an additional 16.7 percent by volume water.

15 The pH of the resultant solution will generally be between 8 and 12, but can be adjusted to almost any pH. Additionally, at these alkaline pH's, the acid quality of the solutions is maintained. The inventors have determined that the solution is very efficient at removing hydrogen sulphide when the pH is adjusted to be above 8. Without being limited to a theory, this is likely the result of the fact that hydrogen sulphide is significantly more soluble at pH 8 than it is at acidic pHs.

20 Having thus disclosed the solution of this invention and how it is prepared, the methods for using the solution will now be disclosed. In its broadest terms, one method of this invention is to prepare the solution as described, and then to bring the solution into contact with a gas that contains hydrogen sulphide. As used herein, "gas" means a form of matter that has no fixed volume and will conform in volume to the space available, and is intended to include mixtures of gases, such as air. For example, the gas can be natural gas that contains hydrogen sulphide, it can be air that contains hydrogen sulphide, and which is emitted from wastewater or from agricultural operations, RV holding tanks, or portable toilets, for example. The solution will, 25 upon contact with the hydrogen sulphide-containing gas or air, remove all or a significant portion of, the hydrogen sulphide. Without being limited to a theory, the hydrogen sulphide reacts with the copper, zinc or iron in the solution to form cupric, zinc or iron sulphide, respectively, which are insoluble molecules that precipitate out of the solution.

Figure 1A shows one embodiment of the method of this invention, in which the gas is bubbled through the solution of the invention. As seen in Figure 1, solution 10 is placed into a container 12 that has an entrance opening 14 and an exit opening 16. Entrance opening is fitted with a device 15, such as a one-way valve, that will prevent solution 10 from running out of container 12. The hydrogen sulphide-containing gas 18 enters container 12 through entrance opening 14 and passes through solution 10 by rising upwards because of its low density. Gas 18 exits container 12 through exit opening 16.

As is apparent, the gas 18 moves through solution 10 as a series of bubbles, which increases the surface area of the interaction between solution 10 and gas 18, and causes turbulence in solution 10, both of which increase the efficiency of removal of hydrogen sulphide from gas 18.

Figure 1B shows another embodiment of the method of this invention, in which solution 10 is passed through tortuous paths 20 in container 12, rather than simply being introduced into container 12 as a volume of liquid. In the method of this embodiment, container 12 again comprises entrance opening 14 and exit opening 16 through which gas 18 will enter into and exit from container 12. These openings are positioned such that gas 18 must pass through the tortuous paths 20 after entering and before exiting container 12. Additionally, container 12 comprises an opening 15 and an exit 17, through which solution 10 will enter and exit container 12, which are positioned such that solution 10 must pass through the tortuous paths 20 after entering and before exiting container 12. As is apparent, the tortuous paths both increase the surface area of solution 10 that can be contacted with gas 18, and also provide turbulence to solution 10, both of which increase the efficiency of removal of hydrogen sulphide from gas 18.

Figure 1B demonstrates an embodiment of this invention in which the tortuous path is created by introducing a plurality of objects 22, such as small circular balls, into container 12. In one embodiment, these balls are approximately the size of a golf ball. However, balls of different or varying sizes, objects that are not round, but oval or discoid, objects that have rounded and flat edges, or objects with flat edges may be used. Any object that would function to cause solution 10 and gas 18 to travel around and between it, is intended to be included herein.

In this embodiment of this method of this invention, solution 10 is introduced into container 12, in such a way that maximizes its contact with the surface of the objects 22. As demonstrated in

Figure 1B, this may be accomplished by spraying solution 10 over the top surface of the objects, whereafter it will trickle down through the various tortuous paths.

Container 12 may be adapted to collect the gas that exits through exit opening 16, for example to collect natural gas. Alternatively, if the gas 18 is not to be collected, such as after hydrogen sulphide has been removed from gases emitting from wastewater or from water used in agricultural operations, the gas would be released directly into the atmosphere, presuming it is otherwise clean.

Another method of this invention is to prepare the solution as described, and then to mix the solution with another liquid that contains hydrogen sulphide. When the solution and the liquid are mixed, and without being limited to a theory, the hydrogen sulphide in the liquid will react with the metal in the solution to form a metal sulphide, an insoluble molecule that precipitates out of the solution. This precipitate can be removed from the mixture, for example by filtration or centrifugation. Alternatively, removal of the precipitate may not be necessary, for instance in a situation where the liquid is a drilling fluid used in oil and gas well drilling.

As will be apparent to those skilled in the art, various modifications, adaptations and variations of the preceding and foregoing specific disclosure can be made without departing from the scope of the invention claimed herein. The following examples are intended only to illustrate and describe the invention rather than limit the claims that follow.

EXAMPLES**EXAMPLE #1**

A mixture of 5% Stabitol and 45% water has a freezing point of around 0°C and a pH of below one. Amine alone has a freezing point of around 0°C and a pH of between 13-14. The inventors have shown that when 5% Stabitol, 45% water and 50% amine are mixed, the resultant product heats up to about 120°F upon mixing the freezing point is below -51°C and has a pH of between 9-10. Normally when these chemicals are used independently of one another in cold weather an anti-freeze would have to be added. This new mixture eliminates the need for an anti-freeze when using this formula in cold weather.

- 10 The percentage of each chemical in this mixture can be varied a great deal, and the resultant mixture will still remain stable, meaning that the metal ion will remain in solution. The percentage of any particular chemical will be based on the application for the mixture, and the pH at which it is required to be effective.

The inventors have made different embodiments of the solutions of this invention, in order to determine what the freezing point of the mixture is. A copper/acid mixture, comprising 5 percent by weight copper and about 2% by volume sulphuric acid was prepared as described in the detailed description. Additionally and acid solution without copper was prepared. Various amounts of this solution were then mixed with monoethanolamine, and the freezing point of the solution was measured. The results are provided in Table 1.

20 **TABLE 1**

VOLUME PERCENTAGE COPPER/ACID MIXTURE	VOLUME PERCENTAGE MONOETHANOLAMINE	FREEZING POINT
25	75	below -51°C
50	50	below -51°C
75	25	-18°C
83.34	16.66	-15°C
VOLUME PERCENTAGE ACID SOLUTION	VOLUME PERCENTAGE MONOETHANOLAMINE	FREEZING POINT
50	50	below -51°C

Additionally, used solution from a test run was subjected to a freezing point analysis, and it was found to freeze at below -51°C .

These results indicate that a solution of acid and amine, or a mixture of acid, amine and metal will have a much lower freezing point than each of the individual liquid components of solution.

5 EXAMPLE 2

The inventors performed a series of field trials with Stabitol, water and copper for removing H_2S from gas. The results were poor, and the inventors believe this to be because the pH was too low. The pH of this formula was at around one. The inventors hypothesized that the pH needed to be at 8 to 10, as the H_2S is much more soluble in a high pH. This creates a much longer
10 contact time for the copper to react with the H_2S .

Because they wanted the solution to be a liquid in a colder environment, the inventors also added an anti-freeze to the Stabitol, water and copper, as they believed the mixture would freeze at around 0°C . When an anti-freeze was added, the results were a little better. However, the
15 inventors found that it was not the anti-freeze that was causing the better results but rather it was the 2% amine that was in the anti-freeze, which was used as a corrosion inhibitor, that was making the difference. The solution remained stable with 2% amine mixed into it. Next, more amine with the hopes of obtaining a product that was even better at removing hydrogen sulphide. When 5% amine was added, the product became unstable, in that copper precipitated out of the solution. When 10% amine was added, a chemical reaction occurred and the product heated up
20 to 120°F and remained stable. Another series of field trials using new formulas was started.

The next series of tests were done using Stabitol, water, copper, amine and glycol/methanol (as anti-freeze agents). Several different formulas were used to determine which ones would work the best. The inventors found that these results were the best we have seen to date. There was a wide range of formulas that could be used. These results were much better than the previous field
25 trials. The pH was between 8 and 11.

The next thing the inventors tested was mixing the Stabitol, water, copper and amine. They found that when mixing this formula they had the same chemical reaction with heat up to 120°F and a freezing point of below -51°C . Using this formula there was no need for an anti-freeze.

One field trial was run to see if H₂S removal was still effective. The results were very good. Continued field trials indicate that there will be a wide range of formulas that will be effective as H₂S scavengers. The pH is around 9 in a 50% (Stabitol, water, copper) and 50% amine mixture. It appears that the formula can be varied in almost any way, and the final formulations used will depend on the application and climate.

TEST # 1.

19L ZINC CHELATE / MONOETHANOLAMINE / GLYCOL C/W 2L LEFT IN FILL HOSE.
SO;5.368L OF ODOR-ZINC IN TOWER.

FUEL GAS PRESS=21 PSI

FLOODED TOWER NOT REVERSE CIRCULATING. 8500PPM GAS STREAM.

TIME	METER READING	PPM	TOTAL CUBIC METERS THROUGH TOWER
930	103.5 CU.M	0	0
945	105.2 CU.M	0	1.5
1000	106.7 CU.M	0	3.0
1015	108.2 CU.M	0	4.6
1022	109.0 CU.M	8500	5.5

SUMMARY: WE CLEANED APPROX 5.3 M3 8500 PPM GAS WITH 5.3L OF OUR ZINC CHELATE POTION. THESE ARE OUR BEST RESULTS YET AND TAKING INTO ACCOUNT THAT THIS TEST WAS DONE AT FLOW RATES OF 6 M3 PER HOUR WHICH IS HIGH FOR THIS TOWER, A CONSERVATIVE CONCLUSION WOULD BE THAT ZINC SEEMS VERY COMPARABLE AND FEASIBLE.

TEST# 2

6L ODOR ABATE/METH/MONOETHANOLAMINE
DISPLACED HOSE

SO 19 L PRODUCT/6L ODORABATE IN TOWER. FLOODED TOWER PACKED
WITH RINGS NOT REVERSE CIRCULATED 8500PPM GAS 24 PSI GAS

TIME	METER READING	PPM	TOTAL CUBIC METERS THROUGH TOWER
921	132.63	0	0
930	132.94	0	.61
945	133.62	0	.99
1000	134.2	0	1.57
1015	134.78	0	2.15
1030	135.3	0	2.67
1045	135.83	0	3.2
1100	136.38	0	3.75
1115	136.9	34	4.27
1121	137.15	54	4.54

	1130	137.45	88	4.82
	1140	137.82	134	5.19
	1145	138.02	169	5.39
	1150	138.2	199	5.59
5	1155	138.4	244	5.79
	1200	138.54	270	5.93
	1205	138.75	341	6.12
	1210	138.93	372	6.3
	1215	139.05	421	6.42
10	1220	139.23	750	6.6
	1230	139.75	4200	7.12
	1240	140.08	6800	7.45
	1250	140.6	8500	7.97

15 SUMMARY: AFTER TABULATING TOTAL CUCES, WE CLEANED 6.75 M3 OF 8500 PPM GAS USING THE SAME FLOW RATE AND TOWER AS BAKER AND WE USED 6 L OF ODOR ABATE SO WE DID 1.125 M3 PER LITRE (8500PPM)

20 TEST# 3

GLYCOL / MONOETHANOLAMINE / WATER BLEND X 19 L
HOSE DISPLACED 8500 PPM GAS 24 PSI ON GAS SYSTEM FLOODED TOWER
PACKED COLUMN

25 NOT REVERSE CIRCULATING NO STABITROL OR ODORABATE.

	TIME	METER READING	PPM	TOTAL CUBIC METERS THROUGH TOWER
	100	140.35	3	0
	115	140.50	5	.15
30	130	141.52	24	1.17
	145	142.10	54	1.85
	200	142.6	98	2.25
	215	143.24	202	2.89
	230	143.85	376	3.50
35	245	144.36	2000	4.0
	300	144.92	6500	4.6
	315	145.48	8500	5.13

40 SUMMARY: FOR THE FIRST TIME WE NOTICED VAPORS COMING OFF GAS SAMPLING LINE. AFTER TABULATING TOTAL GAS, 3.95 M3 WAS CLEANED USING 3.3 LITRES OF MONOETHANOLAMINE

TEST# 4

45 18L OF 50 50 ODORABATE/ MONOETHANOLAMINE; NO GLYCOL OR

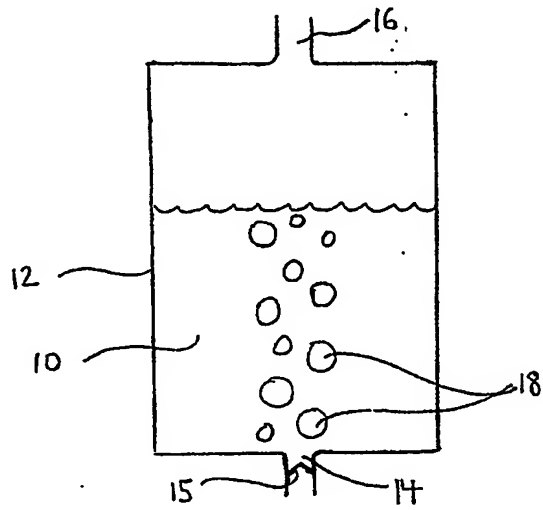
METH TEMP -4 C FLOODED TOWER PACKED TOWER 8500PPM
 24 PSI ON GAS SYSTEM DISPLACED HOSE SO 18 L IN TOWER

	TIME	METER READING	PPM	TOTAL CUBIC METERS THROUGH TOWER
5	312	145.04	0	0
	330	145.67	0	.63
	400	146.7	0	1.66
	430	148.0	0	3.00
	500	148.7	0	3.66
10	530	149.62	0	4.58
	600	150.84	0	5.8
	630	152.04	0	7.0
	700	153.22	15	8.18
	715	153.72	66	8.68
15	730	154.19	99	9.15
	745	154.8	345	9.76
	800	155.34	800	10.3
	815	156.0	2000	11.00
	830	156.5	3000	11.46
20	845	157.0	5000	12.05
	900	157.48	8500	12.44

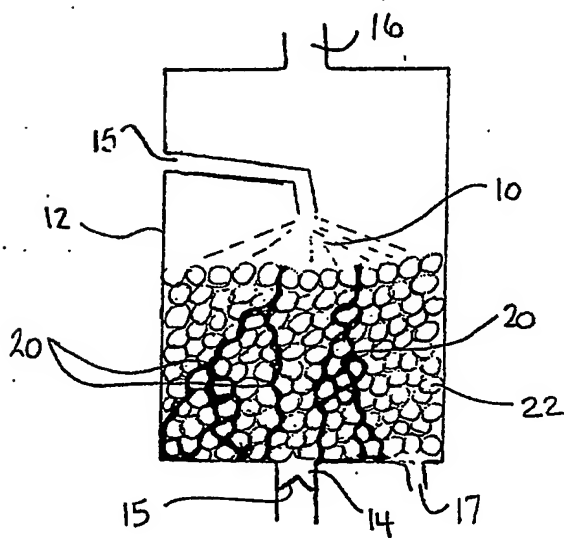
-8 CELCIUS

25 SUMMARY: WE CLEANED 11.38 M3 OF 8500 PPM GAS USING 9 L OF ODOR ABATE.
 SO THIS BLEND = 1.26 M3/L. THIS EQUATES TO 8% BETTER THAN BAKER BEFORE
 TAKING PRODUCT MONOETHANOLAMINE INTO ACCOUNT. I NOTICED THAT
 WITH SEVERAL OF OUR TESTS THAT JUST BEFORE BREAKTHROUGH THE GAS
 FLOW INCREASED SLIGHTLY MAKING ME WONDER IF IT DID NOT HAPPEN IF THE
 TOTAL M3 WOULD HAVE BEEN EXTENDED.

FIGURE 1



A.



B.